THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

AN INVESTIGATION OF THE STACKING PERFORMANCE OF B-FLUTE V3c CONTAINERS FILLED WITH CHICKEN

Project 1108-18

Progress Report One

to

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AN INVESTIGATION OF THE STACKING PERFORMANCE OF B-FLUTE V3c CONTAINERS FILLED WITH CHICKEN

SUMMARY

Full telescope style boxes were constructed from B-flute V3c board and filled with approximately 43 lb. of chicken and 13 lb. of crushed ice to give a gross weight of 60 lb. These boxes were then assembled in three stacks of 7 boxes each in an atmosphere maintained at 39 ± 1°F. and 87 ± 3% R.H. The changes in height of the stacks and their inclination were recorded over a period of 96 hours, the boxes were re-iced and measurements were again taken over a period of 96 hours or until failure.

All stacks remained upright for 6 days and two of the stacks survived 7 days. The deflections of the boxes under load were, in general, small and as a consequence, the boxes appeared to protect the contents from bearing appreciable load.

INTRODUCTION

Surveys of present commercial poultry shipping practices by the F.K.B.I. have indicated that development of suitable corrugated containers could open up a potentially large and valuable market for paperboard manufacturers and converters. The environmental conditions encountered have been described by the members of the F.K.B.I. associated with the market surveys and the following quotations from their reports aptly summarize those conditions.

"In this plant, and in similar plants, the floors are always very wet. The relative humidity in the packing room is high as it is important that the birds not become dry before packing. As the poultry moves along the conveyor line, they are further wetted by sprays. As a consequence, there is always some loose water on the surface or in the interior of the poultry which, with the water of the melting ice, must leak out of the container."

"As the ice melts, the containers themselves must hold the overhead weight, as the shippers do not want the contents to be pressed or squeezed or to lend support to the containers."

"With plugged up drain holes in the trucks, an inch or more of water may collect on the truck floor. This same condition could occur at warehouses, wholesalers, and retail stores. It is not a condition which occurs in the processing plants only, but may continue through the estimated seven days of shelf life of iced shipments."

It was with such considerations in mind thate the stacking tests described herein were instituted by the F.K.B.I. For the exploratory study, the intent was to evaluate the performance of commercially available V3c board under such conditions as have been noted above. Then, the experience so gained could guide further efforts to develop suitable containers which would give adequate performance.

MATERIALS AND BOX CONSTRUCTION

Originally, it was planned to conduct the stacking tests on boxes constructed from A and B—flute V3c board samples. However, on receipt of the samples, they were evaluated for V3c compliance with the following results.

	B-flute	A-flute
Bursting strength, p.s.i.		
Dry--Maximum	485	225
Minimum	410	190
Average	451	205
Wet--Maximum	295	65
Minimum	240	50
Average	262	58
Ply separation	satisfactory	satisfactory

In addition, it was noted that the B—flute sample had a basis weight of 230 lb./M ft.^{2} while the A-flute combined board sample had a basis weight of 126 lb./M ft.^{2}

On the basis of the above data, the B-flute sample complied with the V3c specifications noted in JAN-P-108 whereas the A-flute sample fell far short of compliance. It may be noted that these specifications make no provision for A-flute construction in the V3c series. It was, therefore, decided to carry through the stacking tests using the B-flute sample only at this time.

Full telescope style boxes having the dimensions of 19-1/2 by 12 by 10 inches were constructed at The Institute of Paper Chemistry from the B-flute sheets. These boxes had the body laps on ends and the body sections were slotted 1/2 inch deep. In Figure 1 the scoring diagrams for the body and cover sections are illustrated.

CONTENTS

After considering various dummy packs which would simulate chicken it was determined that 2-pound packages of chicken parts (backs and necks, principally) could be obtained at a cost not far in excess of that required to prepare dummy packs. Because the use of such chicken packages would materially aid in assessing the significance of any results, they were used in loading all boxes.

As received, the chicken was frozen; however, it was thawed overnight and placed in a cold room approximately 24 hours before starting the tests to allow it to come to temperature equilibrium with the test atmosphere of 39 ± 1°F. Each box was then packed with approximately 43 lb. of chicken and 13 pounds of crushed ice to bring the gross weight of the box and contents to 60 lb. The photograph in Figure 2 illustrates the appearance of a typical

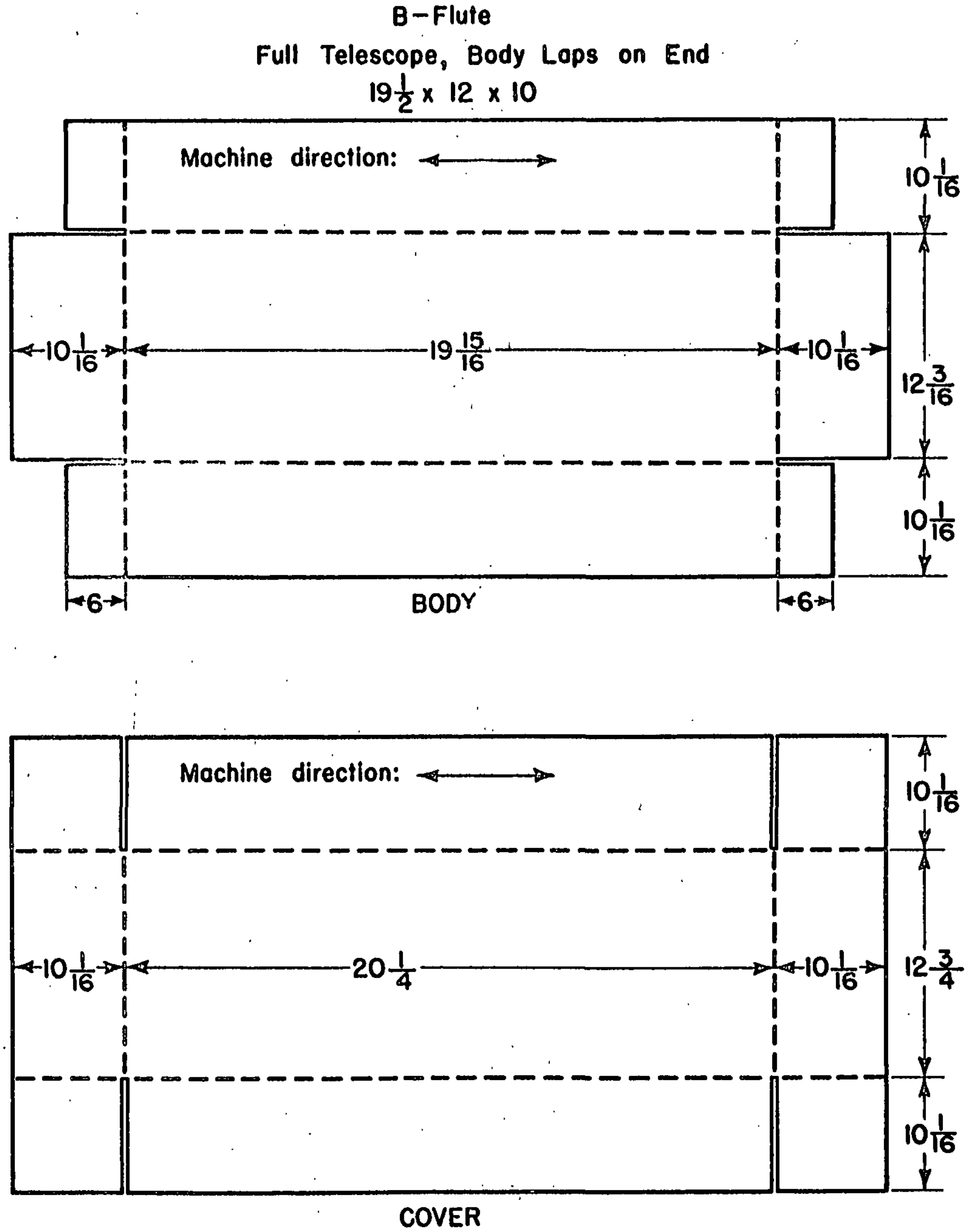

Fig. 1. Scoring Diagram

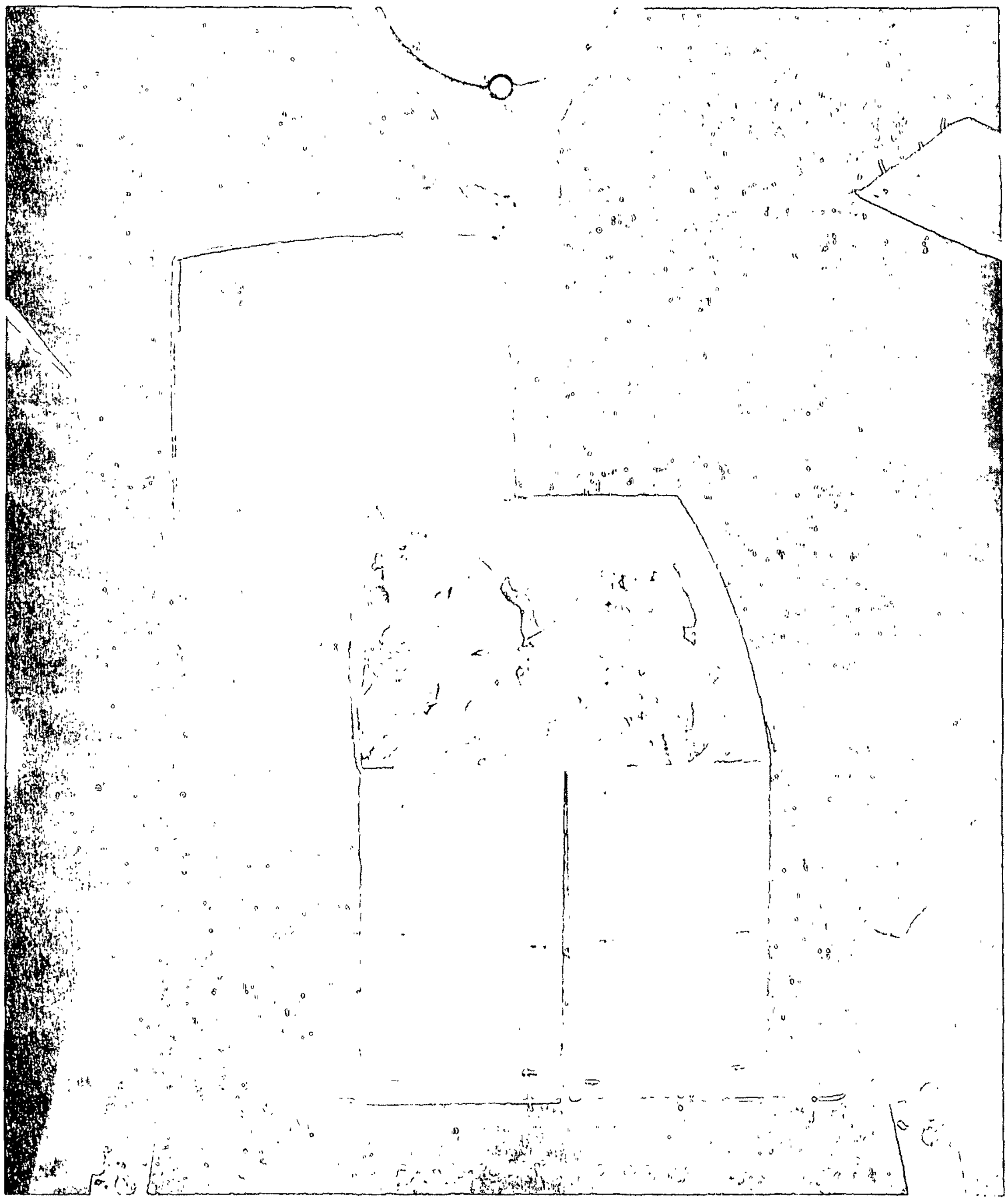

Fig. 2. A Typical Box as Loaded with Chicken

box as filled with chicken while the photograph in Figure 3 shows the same container as its filling was completed with crushed ice.

CONDITIONING

With no particular preconditioning, the boxes were assembled and conditioned for at least 48 hours at 50% and 73°F. prior to filling and stacking in the test atmosphere of 39 ± 1°F. and 87 ± 3% R.H.

TEST PROCEDURE

Three stacks of seven boxes were set up after carefully leveling the base. Small 2-inch square sections of screen were taped to the top four corners of the bottom box and the top box. The sections of screen protruded about 1 inch and were intended to serve as reference marks for the measurements of change in height during the exposure period. For the measurement of stack inclination, a plumb bob was used to establish an initial point on the top surface of the top box in each stack. The difference between the plumb bob position at any time and the initial point measured in the plane of the top surface of the top box was defined as stack inclination for the purpose of this study.

During the test period the following measurements were performed.

1. Height from the base to the four top corners of the bottom box.
2. Height from the base to the four top corners of the top box.
3. Stack inclination.

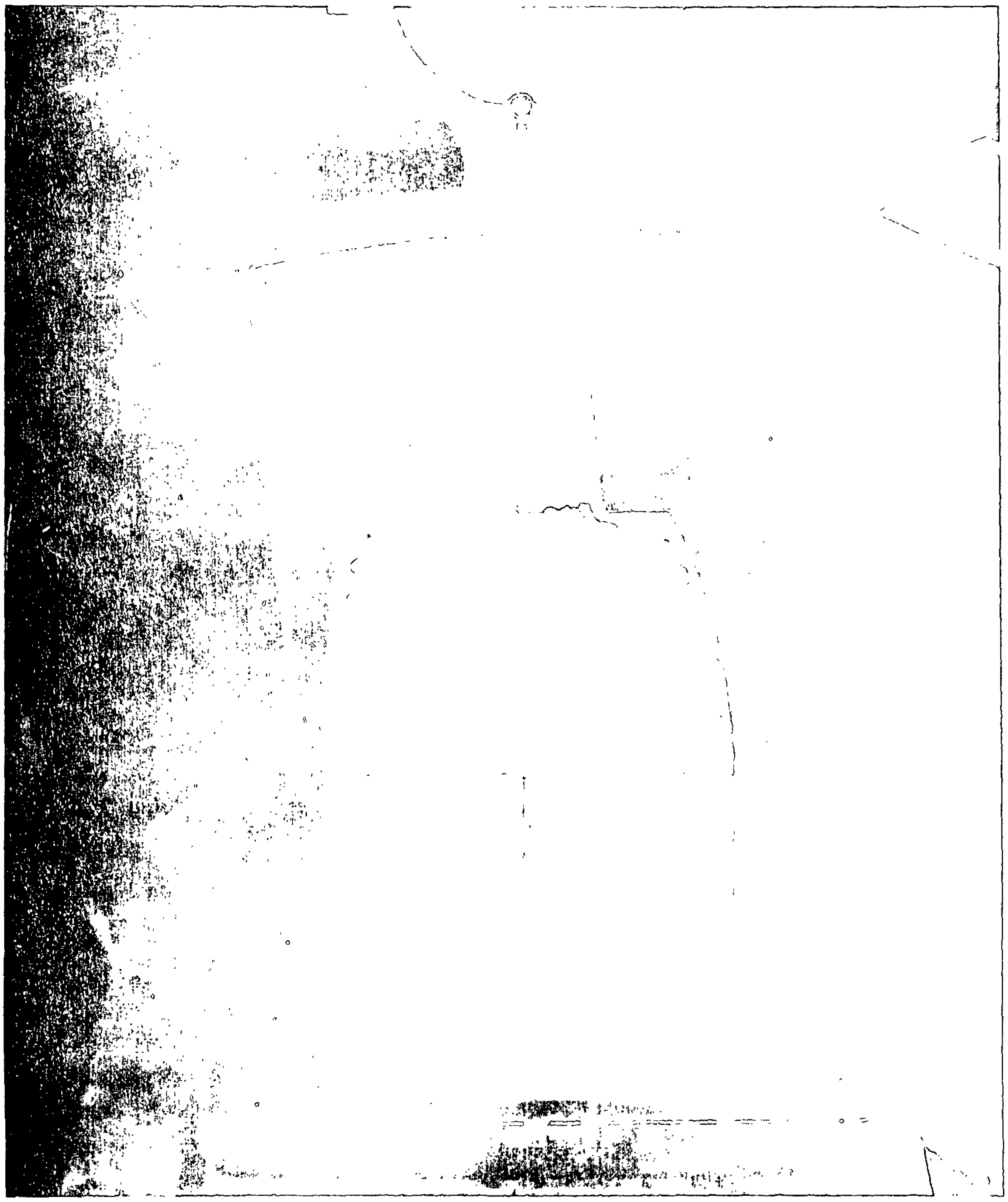

Fig. 3. A Typical Box as its Filling Was Completed with Crushed Ice

The above readings were taken at the start of the test and at 2, 4, 6, 8, 24, 48, 72, and 96 hours. After 96 hours the stacks were disassembled, the boxes were re-iced, stacked in reverse order, and measurements taken as before.

DISCUSSION OF RESULTS

As mentioned previously, three stacks of B-flute telescope style boxes were set up and their deflections and inclination noted over two cycles of 96 hours. The average change in height at the top of each stack is summarized in Table I where it may be noted that during the first cycle of 96 hours there was a gradual decrease in height. At the end of 96 hours, the three stacks had each decreased in height approximately 3/4 inch. After re-icing, it may be noted that stacks 2 and 3 decreased 13/16 and 1-1/8 inch, respectively, in height before failure--falling over--while stack 1 decreased 2-13/16 inches in height before failure. Actually, as it may be noted, stack 2 fell between 48 and 72 hours whereas stacks 1 and 3 fell between 72 and 96 hours. Thus, over-all, all stacks survived at least 6 days and two of the stacks survived at least 7 days.

In Table II the average changes in height of the bottom box are summarized. In connection with these measurements, it should be remarked that the cover sections of the boxes tended to slip over the box immediately below, thus bending the screen sections which were to be used as reference marks. Such slippage could occur either because of misalignment during stacking or because of the pronounced "bowing" of the cover walls. Regardless of the cause, the resulting bending of the reference screen made it

TABLE I

CHANGE IN HEIGHT AT TOP OF STACK

Exposure, hours	Stack 1 Height, inches	Stack 1 Change, inches	Stack 2 Height, inches	Stack 2 Change, inches	Stack 3 Height, inches	Stack 3 Change, inches
			Cycle 1			
0	72	0	72	0	72	0
2	71-14/16	-2/16	71-14/16	-2/16	71-15/16	-1/16
4	71-13/16	-3/16	71-12/16	-4/16	71-14/16	-2/16
6	71-12/16	-4/16	71-12/16	-4/16	71-14/16	-2/16
8	71-12/16	-4/16	71-11/16	-5/16	71-12/16	-4/16
24	71-10/16	-6/16	71-10/16	-6/16	71- 9/16	-7/16
48	71- 8/16	-8/16	71- 8/16	-8/16	71- 6/16	-10/16
72	71- 6/16	-10/16	71- 7/16	-9/16	71- 6/16	-10/16
96	71- 4/16	-12/16	71- 5/16	-11/16	71- 4/16	-12/16
			Cycle 2			
0	71- 4/16	0	71- 1/16	0	71	0
2	71- 1/16	-3/16	71	-1/16	70-15/16	-1/16
4	70-15/16	-5/16	71	-1/16	70-12/16	-4/16
6	70-14/16	-6/16	70-15/16	-2/16	70-12/16	-4/16
8	70-14/16	-6/16	71	-1/16	70-12/16	-4/16
24	70-12/16	-8/16	70-12/16	-5/16	70-10/16	-6/16
48	70- 5/16	-15/16	70- 4/16	-13/16	70- 7/16	-9/16
72	69-1/16	-2-13/16	Failure		69-14/16	-1-2/16
96	Failure				Failure	

TABLE II

CHANGE IN HEIGHT AT THE TOP OF THE BOTTOM BOX

	Stack 1		Stack 2		Stack 3	
Exposure, hours	Height, inches	Change, inches	Height, inches	Change, inches	Height, inches	Change, inches
			Cycle 1			
0	10-4/16	0	10-5/16	0	10-5/16	0
2	10-5/16	+1/16	10-6/16	+1/16	10-5/16	0
4	10-4/16	0	10-5/16	0	10-4/16	-1/16
6	10-4/16	0	10-4/16	-1/16	10-4/16	-1/16
8	10-3/16	-1/16	10-4/16	-1/16	10-4/16	-1/16
24	10-2/16	-2/16	10-3/16	-2/16	10-2/16	-3/16
48	10-1/16	-3/16	10-2/16	-3/16	10-1/16	-4/16
72	10-1/16	-3/16	10-2/16	-3/16	10	-5/16
96	10	-4/16	10-2/16	-3/16	10	-5/16
			Cycle 2			
0	10-4/16	0	10-3/16	0	10-2/16	0
2	10-4/16	0	10-3/16	0	10-2/16	0
4	10-2/16	-2/16	10-2/16	-1/16	10-2/16	0
6	10-1/16	-3/16	10-2/16	-1/16	10-2/16	0
8	10-1/16	-3/16	10-2/16	-1/16	10-2/16	0
24	9-15/16	-5/16	10-1/16	-2/16	10-2/16	0
48	9-12/16	-8/16	9-14/16	-5/16	10	-2/16
72	9-8/16	-12/16	Failure		10-1/16	-1/16
96	Failure		---	---	Failure	

necessary to measure from the base of the lower edge of the cover on the second box in each stack.

With the above in mind, it may be noted that the changes in height of the bottom boxes of all three stacks were small during the first cycle---for example, even after 96 hours the bottom boxes had only decreased in height about 1/4 inch. In the second cycle after re-icing, the deflections were even smaller for stacks 2 and 3; however, the bottom box of stack 1 had decreased 3/4 inch in height before the stack fell.

As discussed previously, measurements of the inclination of each stack were made at each exposure interval. These data are summarized in Table III where it may be noted only stack 1 exhibited an appreciable inclination after 96 hours. In the second cycle, after re-icing, all stacks reached appreciable inclinations before falling. Again in the second cycle, stack 1 exhibited the greatest inclination before failure.

The photographs in Figures 4 and 5 illustrate the appearance of the stacks at the start of the test and after 96 hours. Referring to Figure 4, the small reference screws at each corner may be observed as well as the 1-inch square grid line background. While deviation of the background from the vertical may introduce distortion, it may be observed that stacks 2 and 3 had no appreciable inclination at the start of the test. On the other hand, stack 1 had an inclination of from 1 to 2 inches which may have been caused by either the settling of the loaded boxes themselves or a shifting of the base during stacking.

TABLE III

CHANGE IN STACK INCLINATION

Exposure, hours	Stack Inclination, inches Stack 1	Stack 2	Stack 3
	Cycle 1		
0	0	0	0
2	20/64	9/64	6/64
4	20/64	11/64	13/64
6	44/64	6/64	20/64
8	58/64	22/64	24/64
24	1-22/64	42/64	28/64
48	1-58/64	1	38/64
72	2-16/64	1-9/64	40/64
96	2-54/64	1-17/64	40/64
	Cycle 2		
0	0	0	0
2	17/64	32/64	11/64
4	22/64	38/64	33/64
6	26/64	40/64	20/64
8	32/64	44/64	26/64
24	1-34/64	1-23/64	50/64
48	2-32/64	4-17/64	1-8/64
72	8-30/64	Failure	4-38/64
96	Failure	--	Failure

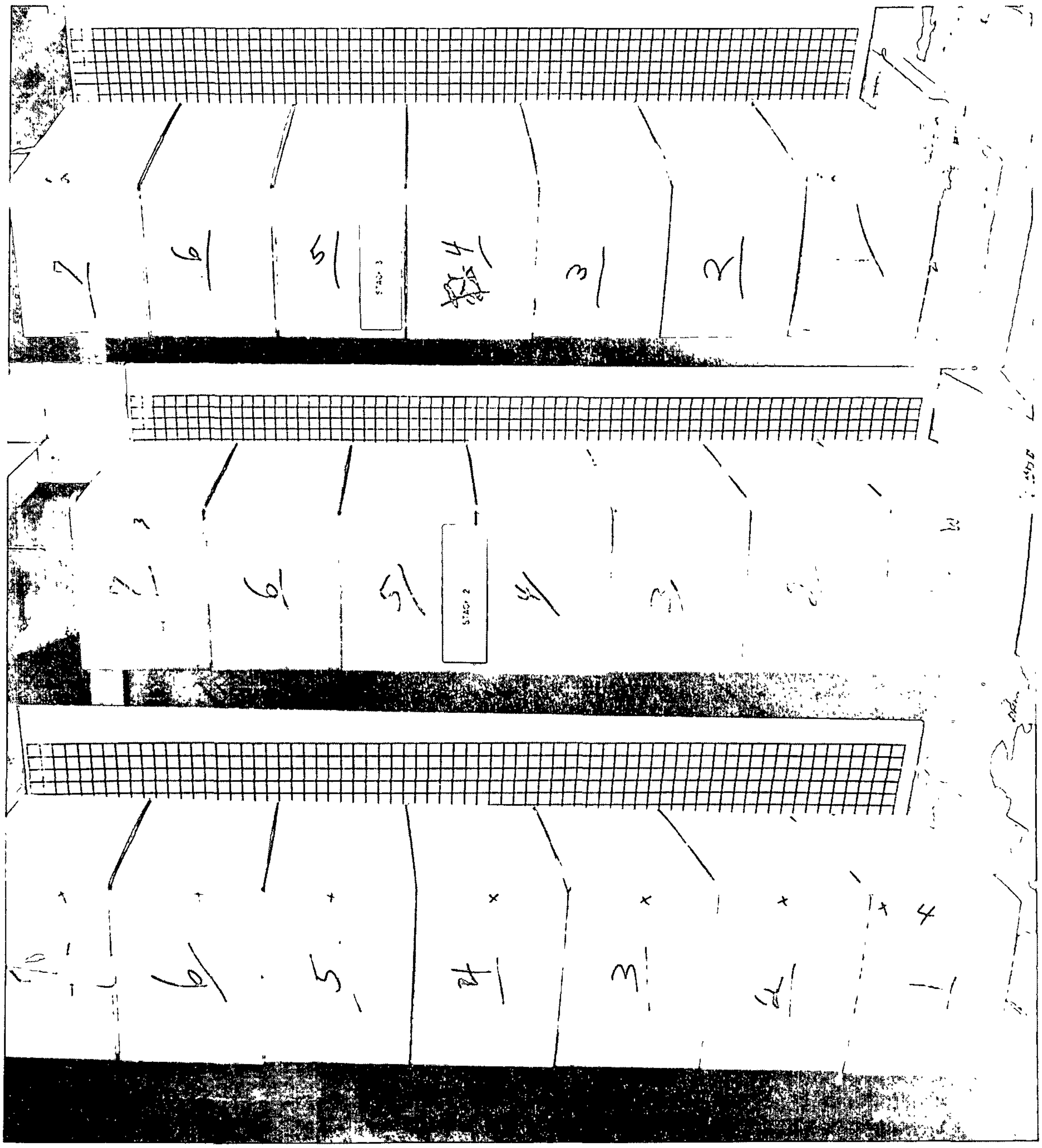

Fig. 4. The Appearance of the Three Stacks at the Start of the Test.

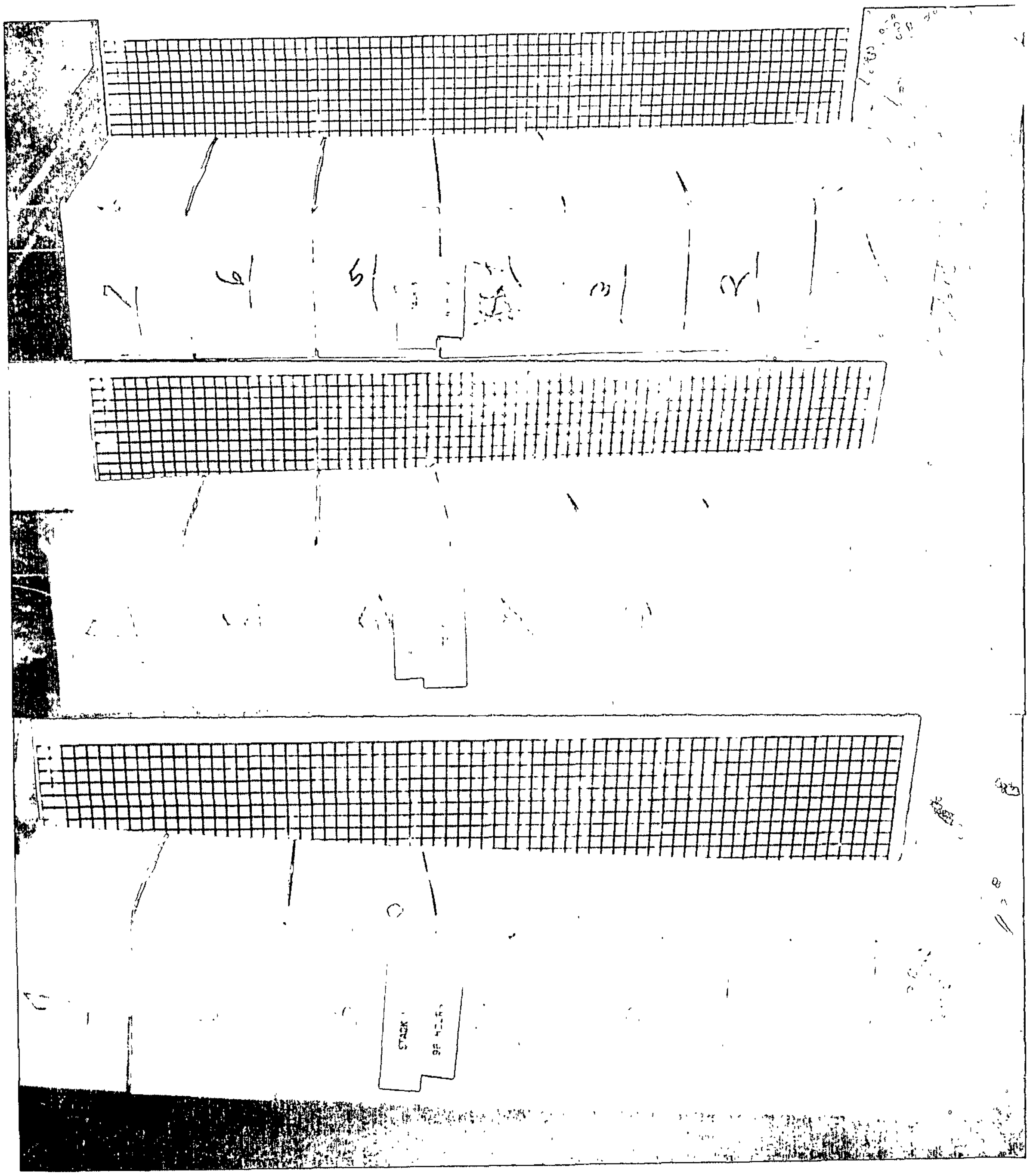

Fig. 5. The Appearance of the Three Stacks after 96 Hours Exposure

In Figure 5 the distortion of the reference screens by the covers of the second boxes is more or less evident. The dripping ice and blood may be observed at the base of all stacks and it appears as if the bottom box of stack 1 shows most evidence of water soaking.

In Figure 6 may be found a photograph of stack 3 after it failed between 72 and 96 hours. The bowing of the side panel is clearly shown by the second box and the "dishing" inward of the top surface of the second box is clearly evident. The "dishing" was characteristic of all boxes when the stacks were disassembled and re-iced after 96 hours.

In summary, these B-flute full telescope-style containers performed reasonably well under the adverse conditions encountered in these tests. The deflections of the boxes under load were, in general, small and as a consequence, the contents would not be required to carry an appreciable part of the stacking load. All these stacks remained upright for 6 days and two of the stacks survived 7 days which may be compared with the estimated 7-day life of iced shipments.

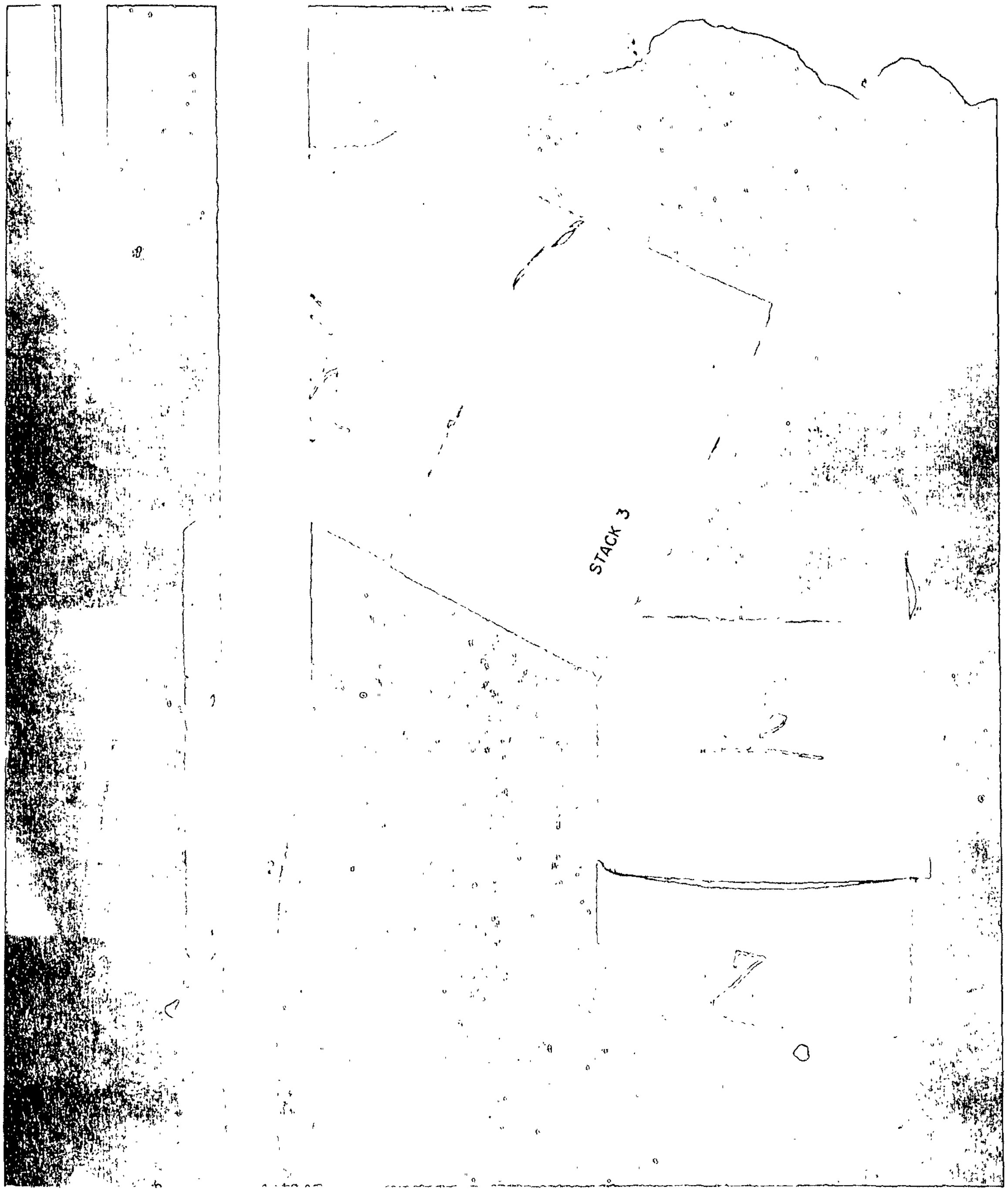

Fig. 6. A Photograph of Stack 3 as it Appeared after "Failure"

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